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Invited Perspective: Current Breast Milk PFAS Levels in the United States and Canada Indicate Need for Additional Monitoring and Actions to Reduce Maternal Exposures

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Per- and polyfluoroalkyl substances (PFAS), a large group of synthetic chemicals that have been made for more than 70 years, are a current focus of public health concern. Several long-chain PFAS, with human half-lives of several years, are detected in the blood serum of virtually all residents of the United States and many other nations (Lau 2015). PFAS do not break down in the environment, and even low concentrations in drinking water can surpass exposures from common sources, such as food and consumer products (Post et al. 2017). There is substantial evidence for health effects of PFAS, including decreased antibody response to vaccines, increased serum lipids and liver enzymes, and decreased birth weight, even at general population exposure levels (Fenton et al. 2021), and the risks are increased with additional exposure from contaminated water. It is well established that breast milk can be an important source of PFAS exposure and that infants are a sensitive subpopulation for their adverse effects (Goeden et al. 2019). In this issue of Environmental Health Perspectives, LaKind et al. (2022) discuss measured and estimated PFAS levels in breast milk in North America and evaluate the potential significance of these levels.

First, LaKind et al. (2022) reported that data on PFAS in breast milk in the United States and Canada are very limited; only three general population studies, with 95 U.S. and 13 Canadian participants in total, were identified. The four long-chain PFAS [i.e., perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), and perfluorohexane sulfonate (PFHxS)] that are ubiquitous in the blood serum of U.S. residents (CDC 2021) were detected in breast milk in the two U.S. studies, whereas only PFOA was detected in a smaller study from Canada, possibly because of insufficient analytical sensitivity. Clearly, more data are needed.

Next, LaKind et al. (2022) used mean breast milk:maternal serum PFAS ratios from the literature to estimate breast milk PFAS concentrations in the general population. They used serum PFAS data from two national surveys—the U.S. National Health and Nutrition Examination Study (NHANES) and the Canadian Health Measures Survey—and from exposure assessments conducted by the Agency for Toxic Substances and Disease Registry (ATSDR) in communities with contaminated drinking water. Although not discussed by LaKind et al. (2022), when drinking water is contaminated, concentrations of long-chain PFAS in breast milk can be estimated to be approximately three to eight times higher than those in maternal drinking water. These predictions are made by combining maternal serum levels estimated from serum:drinking water ratios of 114:1 for PFOA (Post et al. 2012; NJDWQI 2017) and 200:1 for PFOS (NJDWQI 2018), PFNA (NJDWQI 2015), and PFHxS [calculated from half-life and volume of distribution data from NHDES (2019)] with the breast milk:serum ratios used by LaKind et al. (2022)—PFOA: 0.073:1; PFOS and PFHxS: 0.013:1; PFNA: 0.03:1. To put the relationship between exposures to the mother and the breastfed infant into a broader context, data from mother–infant pairs from the general population indicate that, although serum levels of long-chain PFAS are similar or lower in the infant compared with the mother at birth, they increase several times from birth to 6 months of age in breastfed infants (Fromme et al. 2010).

These higher exposures through breast milk are of concern because PFAS are associated with early life health effects. As an example, in a study based on archived blood samples from the late 1990s (Abraham et al. 2020), serum PFOA levels at 1 year of age were associated with decreased antibody response to three vaccines. In that study, mean serum PFOA levels were more than four times higher in breastfed children than in those who were formula fed.

Finally, LaKind et al. (2022) compared measured and estimated breast milk levels of the four long-chain PFAS to child screening levels (environmental media evaluation guides, or EMEGs) set by the ATSDR for PFAS in drinking water (ATSDR 2019). EMEGs are based on ATSDR minimal risk levels (toxicity factors for noncancer health effects)—which are similar in concept to reference doses set by the U.S. Environmental Protection Agency (EPA)—and the drinking water ingestion rate from birth to 1 year of age. LaKind et al. (2022) reported that almost all measured and estimated breast milk PFOA and PFOS concentrations, including U.S. general population estimates from NHANES data, exceeded the ATSDR EMEGs.

Relevant to this point, PFAS exposures in breastfed infants whose mothers ingest contaminated water can be higher than in infants who consume formula prepared with the same water. A transgenerational exposure model developed by the Minnesota Department of Health (Goeden et al. 2019) considered exposures to formula-fed and breastfed infants from PFAS-contaminated water. This model predicts that peak serum PFOA levels in breastfed infants are six times higher than in adults and four times higher than in formula-fed infants and that it takes many years for these elevated levels to decrease to those found in formula-fed infants or adults. Minnesota and several other states have used this model to develop drinking water guidelines for long-chain PFAS including PFOA, PFOS, PFNA, and PFHxS (Post 2021).

In addition, the current toxicity factors used in PFAS drinking water guidelines developed by the ATSDR, the U.S. EPA, and most U.S. states are based on animal studies rather than human data (Post 2021). The European Food Safety Authority recently

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finalized a tolerable daily intake for long-chain PFAS (EFSA CONTAM Panel et al. 2020) based on human data (Abraham et al. 2020) for the maternal dose resulting in decreased vaccine response in breastfed infants at 1 year of age. In November 2021, the U.S. EPA asked its Science Advisory Board to review draft documents supporting updated PFOA and PFOS toxicity factors based on human epidemiological studies (U.S. EPA 2021). Because human epidemiological studies in the general population demonstrate health effects at PFAS exposures far below the PFAS doses generally used in animal toxicology studies (U.S. EPA 2021), these recent toxicity factors are much more stringent than current U.S. toxicity factors, which are based on animal toxicology data.

Public health efforts must recognize that concentrations of long-chain PFAS in breast milk result from long-term past maternal exposures. Because elimination of PFAS from the body takes many years after exposure ends, reductions in maternal exposure will decrease levels in breast milk over time but not immediately. Reducing concentrations of PFAS in breast milk in the general population will require actions to decrease or eliminate maternal exposure from common sources such as food and consumer products. Addressing the higher breast milk concentrations from maternal exposure to PFAS in drinking water will require identifying contaminated drinking water sources and establishing health-protective PFAS drinking water guidelines that consider both exposures and risks to breastfed infants.

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